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Examining the Possibility of Using Visual Programming Language Scratch in Preschool Education for Learning Arithmetic Operations

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Abstract: The aim of the research is to examine the potential of harnessing the visual programming language Scratch for learning arithmethic operations in preschool education as well as to find out wheather a visual programming environment intended for algorithmic thinking development can enhance learning outcomes and contribute to better understanding of arithmetic operations. In the pedagogical experiment, which was realized during two school years, 48 children aged 5 to 6 years were involved. The children were separated into three groups in accordance with the learning method. The traditional method of learning numbers, addition and subtraction was implemented in the first group. The second group of children learned numbers and arithmetic operations using visual programming language Scratch. In the third group a combined method that included the traditional teaching method and the use of the programming language Scratch was applied. The comparison of different methods of learning arithmetic operations in order to determine the difference in children's achievements was performed by using Mann-Whitney test. The research results indicate that children from the experimental group, in which combined learning method was applied, exceed achievements of the other groups. Accordingly, it could be concluded that the application of visual programming language in preschool education represents an extraordinary complement to the traditional method of learning arithmetic operations.

Keywords: *addition, information-communication technologies, preschool age, subtraction, visual programming environment.*

Introduction

Contemporary society also requires contemporary education. As children are surrounded by modern technologies every day, it is important that they also have the appropriate education. Developed countries make extensive use of information and communication technologies (ICT) for educational purposes. In most countries, its introduction in primary education is becoming very important, while the application of ICT in preschool education is neglected (Belenzada, Mićić, Šaponjić and Kojović, 2021).

Bolstad (2004) emphasizes the importance of using modern technologies including ICT in the educational process of early childhood. The potentials of using modern technologies in early childhood include: enhancing children's learning and play experiences, supporting and strengthening professional learning and development, and supporting and strengthening relationships and communication between early childhood interests, parents and other people connected to the child and its closest environment (Bolstad,2004). There is an increasing number of research whose results indicate the importance and advantages of using ICT in early childhood (Belenzada et al., 2021; Bers, 2018; Mamutović, Marković and Stanisavljević Petrović, 2020; Mamutović, Stanisavljević Petrović and Marković, 2021; Masoumi, 2015; Nikulina, 2016).

Today, block-based coding is a widespread tool in teaching computational thinking especially algorithmic thinking (McManus, 2019). Visual programming environments have a potential to be the future of the educational process regarding their beneficial features that provide knowledge acquisition in a

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superior and more novel way. In educational practice visual programming language Scratch is the most often used. Programming in Scratch is block-based programming intended for initial learning of programming and development of algorithmic thinking in children. This visual programming language is increasingly the subject of researches which treat the use of programming languages in lower grades of primary school (Bodaker and Royenberg-Kima, 2023; Fagerlund, Vesisenaho and Häkkinen, 2022; Garcia, 2023; Kalelioğlu and Gülbahar, 2014; Krizsan and Lambic, 2024; Montiel-Cabello and Gomez-Zermeño, 2021; Saez-Lopez and Miyata, 2013; Saez-Lopez, Roman-Gonzalez and Vazquez-Cano, 2016). The results obtained by the aforementioned authors show that computer management skills, logic, learning programming concepts, ability to solve problems, motivation, creativity and active learning could be advanced by harnessing the block-based programming.

There are also studies whose results indicate the possibility and importance of using visual programming environment in early childhood. Examining the role of visual programming tools in the algorithmic thinking development in preschool age is a research aiming to find out the attitude of preschool and younger school age children to programming. Taking into consideration the impact of programming approaches on the development of algorithmic thinking in the research two programing tools Scratch and Lightbot were investigated. In this research the overall conclusion implies that both groups of children had comparable results in the computational thinking development especially algorithmic thinking. Also, they have evolved a positive attitude towards programming (Rose, Habgood and Jay, 2017). Oliveira and Conceição Lopes (2011) carried out research with preschool children in order to understand how six-year-olds communicate and express themselves using new technologies. Scratch was used as a tool to create projects whose content was motivated by stories and poetry that were adapted to the children's age. The authors pointed out that it was a challenge for the children to use Scratch, which encouraged them to use their imagination when animating stories and songs.

Aforementioned results of research on the application of visual programming languages indicate that their harnessing has a progressive impact on achievements in early education. Hence, it is necessary to realize further researches in order to enlarge implementation of new technologies including visual programming languages in preschool educational work. Starting from Piaget's theory of cognitive development (Miočinović, 2002), according to which children in the period of concrete operations, which is reached around the age of 6, can think logically and perform arithmetic operations, and having in mind that the visual programming environment contributes to logical thinking development (McManus, 2019), the idea arose to examine the possibility of improving the learning of arithmetic operations by using a visual programming language Scratch in preschool education.

Materials and Methods

Children aged 5 to 6 attending a preparatory preschool program in the year before starting school participated in a research conducted at the Preschool "Boško Buha" in Vrbas (Republic of Serbia). The examiner is a professional preschool teacher who works daily with the children. The preschool teacher did not know the children before the research began, which ensured objectivity in the assessment process. Having in mind children's age, the research realized with the children's and parents' accordance after they were informed about all the relevant details of the research, including general information about the research, the purpose and objectives of the research, the research tasks, the research methodology, the absence of potential risks and negative consequences of participation in the research, as well as the anonymity of the data collection process. They were also made aware of the fact that participation in the research is voluntary and that they can withdraw at any time without explanation. The method of data processing and publication of research results were presented to them. Finally, they were informed that if they have any objections to the research procedure, who can they contact.

In the research, which was carried out during two school years, 48 children participated. The first part of the research was carried out during June in the 2022/23 school year and 21 children participated in it. The second part of the research was conducted during December of the 2023/24 school year, in which 27 children participated. The research was conducted over two school years with different groups of children in order to check the repeatability of the trend of the results obtained and the conclusions drawn, as well as to increase the size of the research sample. Before starting the research, the degree of children's previous comprehension of numbers, digits, addition and subtraction was determined based

on the pretest results. The pretest was developed according to the Fundamentals of the preschool preparatory program (Tomić, 2000). The expected learning outcomes of this preschool educational program are that children should master the arithmetic operations of addition and subtraction of numbers up to 10, including number 0 in the year before starting school. The standardized tests from the Manual (Mikić and Jovanović, 2019) were used in the assessment process. These tests usually used to assess the knowledge of numbers and arithmetic operations of preschool children. All children solved the pretest simultaneously in the allotted time of half an hour, which was enough for the children to answer on all the questions. Hereafter, the preschool teacher was performed test evaluation on the basis of the Regulations on standards of educational achievements (2024) issued by the Ministry of Education. In this Rules thresholds for a certain level of knowledge are provided. The pretest consists of 31 questions that are divided into three groups.

The first task is composed of 11 questions related to knowledge of numbers up to 10 including number 0. In the first task the children were required to count how many apples they see and to write down the digit that represents that number. If the child counted the apples correctly and wrote the correct digit, the answer was recorded as correct, otherwise as incorrect. The obtained results of the first task of the pretest in both years of research are shown in Table 1. The highest percentage of children (33.3%) showed on the pretest that they knew numbers and digits completely. Also, research results indicate that more than 50%, that is, 64.6% of the children know numbers and digits because they had at most one incorrect answer in this task.

The second task contains 10 questions related to the arithmetic operation of addition. In the second task, the children added numbers up to 10 including number 0. The pretest questions are designed in that way, based on children's answers, it is possible to determine whether the children understand the addition operation based on the commutativity property, as well as the value of the number 0. One example of the second task which includes commutativity property is shown in Figure 1.

Table 1. *Numbers Task- number and percentage of children in both years of the research*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
11	8 (38.1)	8 (29.6)	16 (33.3)	know completely
10	7 (33.3)	8 (29.6)	15 (31.3)	know
8 - 9	5 (23.8)	2 (7.4)	7 (14.6)	know partially
0 - 7	1 (4.8)	9 (33.4)	10 (20.8)	do not know

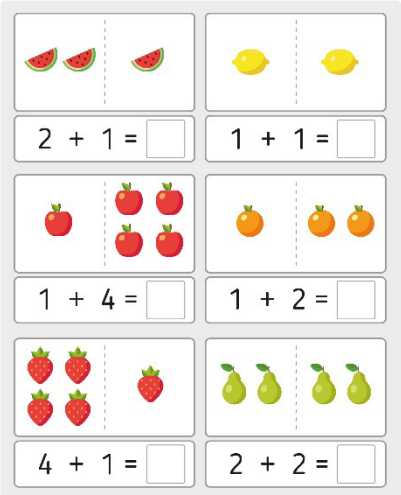

Figure 1. Example of addition task

The results of the second task show that the largest percentage of children (31.2%) partially knows addition, while a quarter knows and 14.6% of them know the addition operation completely (Table 2).

The children subtracted numbers up to 10 including number 0 in the third task. The obtained results are shown in Table 3. One can notice that more than a half of children (56.2%) do not know the subtraction operation. In the first year of the research, no child showed that he/she knows or knows completely

the subtraction operation, while in the second year of the research there was one child who knows the subtraction operation completely and one who gave one incorrect answer.

Table 2. *Addition Task- number and percentage of children in both years of the research*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	3 (14.3)	4 (14.8)	7 (14.6)	know completely
8-9	4 (19)	8 (29.6)	12 (25)	know
3-7	9 (42.9)	6 (22.2)	15 (31.2)	know partially
0-2	5 (23.8)	9 (33.4)	14 (29.2)	do not know

Table 3. *Subtraction Task- number and percentage of children in both years of the research*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	0 (0)	1 (3.7)	1 (2.1)	know completely
8-9	0 (0)	1 (3.7)	1 (2.1)	know
3-7	13 (61.9)	6 (22.2)	19 (39.6)	know partially
0-2	8 (38.1)	19 (70.4)	27 (56.2)	do not know

In the Figure 2 pretest results are shown. Based on all the obtained results of the pretest, sixteen children had all the correct answers in the first task, which means that a third of the children in both years of the research, i.e. 33.3%, know numbers and digits completely. Out of sixteen children, seven children had all the correct answers in the first and second tasks, that is, 14.6% know numbers, digits and addition completely. One can notice that one child had all correct answers in all three tasks in both years of the research.

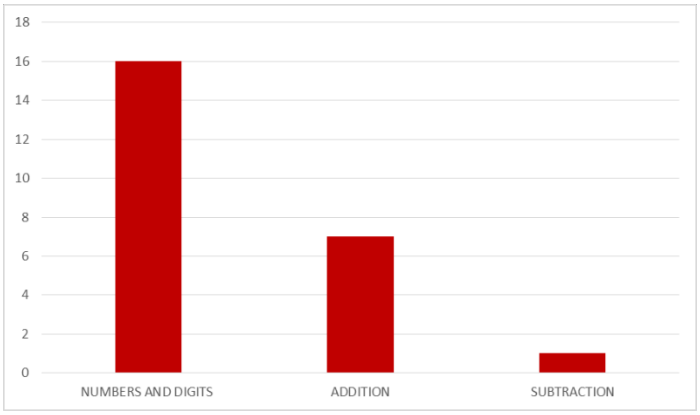

Figure 2. Pretest results

The children were divided into three groups accordingly the pretest results and the confirmed previous knowledge. Kruskal-Wallis test was performed in order to determine whether there were statistically significant differences in prior knowledge between children divided into three groups based on the pretest results. In the Table 4 obtained values of Kruskal-Wallis test for pretest results are given. The obtained H values imply that at significance level $p < .05$ there is no statistically significant difference in the pretest results. Hence, the previous knowledge of arithmetic operations between the groups of children which will learn using various learning methods was equal.

Table 4. *Kruskal-Wallis test for pretest results*

Task	N	H	p
Addition	48	5.467	0.065
Subtraction	48	3.543	0.170

The research lasted four weeks. The children learned arithmetic operations of addition and subtraction three times for 3 hours each week of the research, which is a total of 36 hours of learning over the course of one month. It should be noted that during one 8-hour working day, there were 3 sessions. Each session lasted one school hour, with breaks of about 2 hours between sessions.

The traditional method of learning addition and subtraction was used in the first group of children. During four weeks of learning they did various exercises according to the recommendations from the Fundamentals of the preparatory preschool program (Tomić, 2000). Some of the exercises that were carried out during the research are described below. The second group of children used visual programming language Scratch for learning during four weeks. Some of the exercises with which children from the second group have learned arithmetic operations according to recommendations and instructions (Dikins, Stovel and Melmot, 2018) are described below. In the third group, both approaches to learning arithmetic operations were equally represented. The children learned addition and subtraction up to 10 for 2 weeks using the traditional learning method and did the same exercises as the children in the first group during the first two weeks of the research. In the second part of the research, also for two weeks, the children learned addition and subtraction up to 10 using the visual programming language Scratch and did the same exercises as the children in the second group during the second two weeks of the research.

In the Fundamentals of the preparatory preschool program, it is planned that children overcome operations of addition and subtraction within the first ten (Tomić, 2000). However, most of them, even know how to count, do not know the position of the number in the number sequence and the value of the number. It is especially important that they understand and notice the value of the number 0.

During the research, children in the first and third groups did various exercises from the Fundamentals of the preparatory preschool program (Tomić, 2000) intended for working in a traditional way with children in the year before starting school. These exercises helped them understand and determine the value of a number and its place in a number sequence through play. Also, they did exercises that help them understand and learn the arithmetic operations of addition and subtraction.

One exercise that enables children to understand the value of a number and therefore its place in a number sequence is the following: Chairs are arranged in 3 columns of 5 chairs one behind the other. There are five children in each column standing one behind the other. In this exercise each child is a number from 1 to 5. When they hear the number 5 spoken, the children from all the columns in the place number 5 should find their place on the chair that is fifth in order in the number sequence.

Another exercise that allows children to learn arithmetic operations is the exercise with baskets and objects in them. There are two baskets in front of the children. One is empty and there is one candy in the other basket. By adding and subtracting candies or some other objects such as pencils, felt-tip pens, cubes, balls, etc. from the basket while constantly counting how many are currently in the basket, children determine numbers and adopt addition and subtraction operations on concrete examples using the objects available to them in the study room.

The exercise with cards marked with the numbers from 0 to 10 and the signs +, - and = was implemented for children to learn addition and subtraction operations. The cards are placed in front of the children and they are all mixed up. Children have the task of finding the corresponding card with that number when they hear a number. Then when they hear a plus or minus sign and another number they also need to find the matching cards. After that, they find the = sign and say what the total result of the arithmetic operation is. During this exercise, children add and subtract using their 10 fingers. The exercise is repeated by the children giving each other different combinations of numbers and operations.

Some of the exercises with which children from the second group (learning method using the visual programming language Scratch) and the third group (combined learning method) have learned arithmetic operations are described below. In the first exercise, the children had the task of dragging the addition block and the subtraction block onto the desktop. Children can easily see which blocks they are, they can be recognized by the (+) and (-) signs. Then they enter numbers into the blocks and by clicking on them they get the correct solution to a specific task. Before that, they add or subtract themselves using their

fingers before clicking to see the correct solution which the cat character shows them on the desktop. The children independently gave each other tasks that contained different combinations of numbers for both addition and subtraction.

Also, the previously described exercise with the placement of cards was realized. Children placed cards with different combinations of numbers up to 10 and addition or subtraction operations and then entered these combinations into blocks in the visual programming language Scratch. The children very easily adopted the way in which it is possible to calculate using the cat character. Thus, learning through this method was interesting and easy for them because they were playing and competing with the cat.

Results

After completing the process of learning arithmetic operations of addition and subtraction, the children solve the identical test again as during the initial knowledge assessment.The results of the first task of the test for all three groups are shown in Tables 5,6 and 7. Based on the obtained results, it can be concluded that the children, who studied using the combined method, have the best achievments, i.e. 75% of them in both years of the research showed that know numbers and digits completely, while 56.2% of children that studied using the traditional learning method showed that know numbers and digits completely. Learning in the programming language in the first year of research showed that the largest percentage of children (42.8%) partially know, while in the second year of research 55.5% of children know numbers and digits completely. Also, based on the results obtained, it can be noted that all children who studied using the combined learning method in the first year of the research gave at most one incorrect answer, i.e. that all children know numbers and digits, while when applying the traditional learning method, that percentage is 85.8% and with the programming language Scratch is 57.2%. In the second year of research, 88.9% of children who studied using the combined method knew numbers and digits, while with the traditional method, that percentage was 77.7%, and with the programming language Scratch was 66.6%. Based on the obtained results, it can be noted that the children who learned numbers and digits using the combined learning method in both years of the research reached the best achievements, that is, a total of 93.7% of children know numbers and digits.

Table 5. *Numbers Task- number and percentage of children in the both years of the research (traditional method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
11	3 (42.9)	6 (66.6)	9 (56.2)	know completely
10	3 (42.9)	1 (11.1)	4 (25)	know
8-9	1 (14.2)	0 (0)	1 (6.3)	know partially
0-7	0 (0)	2 (22.3)	2 (12.5)	do not know

Table 6. *Numbers Task- number and percentage of children in the both years of the research (Scratch method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
11	2 (28.6)	5 (55.5)	7 (43.8)	know completely
10	2 (28.6)	1 (11.1)	3 (18.7)	know
8-9	3 (42.8)	3 (33.4)	6 (37.5)	know partially
0-7	0 (0)	0 (0)	0 (0)	do not know

Table 7. *Numbers Task - number and percentage of children in the both years of the research (combined method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
11	5 (71.4)	7 (77.8)	12 (75)	know completely
10	2 (28.6)	1 (11.1)	3 (18.7)	know
8-9	0 (0)	1 (11.1)	1 (6.3)	know partially
0-7	0 (0)	0 (0)	0 (0)	do not know

The results obtained for the second task of the addition operation are shown in Tables 8, 9 and 10. Based on the obtained results, it can be noticed that the children who learned with the traditional learning method showed the worst results in both years of the research, i.e. that 18.7% of them know addition completely, while this percentage is higher among children who learned using the visual programming language Scratch and it was 25%. The best results in both years of the research were shown by children who studied using the combined learning method. In this group, half of the children know addition completely. Also, it can be observed that all children from the third group in the first year of research know the arithmetic operation addition, while in the first group this percentage is 42.9% and in the second only 28.6%. In the second year of research, 66.6% of children who learned using the combined method know the addition operation, 55.6% of the children who learned using the traditional method and less than half of the children (44.5%) who learned using the Scratch programming language know the addition operation. Based on the obtained results, it can be observed that in the group that learned using the combined learning method, there are no children who do not know the addition operation, while in the other two groups there were such children.

Table 8. *Addition Task- number and percentage of children in the both years of the research (traditional method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	1 (14.3)	2 (22.2)	3 (18.7)	know completely
8-9	2 (28.6)	3 (33.4)	5 (31.3)	know
3-7	4 (57.1)	2 (22.2)	6 (37.5)	know partially
0-2	0 (0)	2 (22.2)	2 (12.5)	do not know

Table 9. *Addition Task- number and percentage of children in the both years of the research (Scratch method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	1 (14.3)	3 (33.4)	4 (25)	know completely
8-9	1 (14.3)	1 (11.1)	2 (12.5)	know
3-7	4 (57.1)	4 (44.4)	8 (50)	know partially
0-2	1 (14.3)	1 (11.1)	2 (12.5)	do not know

Table 10. *AdditionTask- number and percentage of children in the both years of the research (combined method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	4 (57.1)	4 (44.4)	8 (50)	know completely
8-9	3 (42.9)	2 (22.2)	5 (31.3)	know
3-7	0 (0)	3 (33.4)	3 (18.7)	know partially
0-2	0 (0)	0 (0)	0 (0)	do not know

The results for the third task are shown in Tables 11, 12 and 13. The highest percentage of children in both years of the research showed that they partially know the arithmetic operation subtraction. In the first year of the research, this percentage in the group that learned using the traditional learning method was 85.7%, while in the group that learned using the combined method, it was 57.1%, and among the children who learned using the Scratch programming language, it was 42.8%. In the second year of the

research, children in the first and third group have the same results, that is, 55.6% of children partially know the subtraction operation. The application of the visual programming language Scratch gave the worst results because the largest percentage of children (44.4%) do not know the subtraction operation. The best results in both years of the research were shown by children who learned using the combined method, as 37.4% of them show that they know the operation of subtraction, while in the first group that percentage is 12.5% and in the second 25%. In the second group 12.5% of children and in the third group 18.7 % know subtraction completely, while in the first group no child knows subtraction completely.

Table 11. *Subtraction Task- number and percentage of children in the both years of the research (traditional method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	0 (0)	0 (0)	0 (0)	know completely
8-9	1 (14.3)	1 (11.1)	2 (12.5)	know
3-7	6 (85.7)	5 (55.6)	11 (68.8)	know partially
0-2	0 (0)	3 (33.3)	3 (18.7)	do not know

Table 12. *Subtraction Task - number and percentage of children in the both years of the research (Scratch method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	2 (28.6)	0 (0)	2 (12.5)	know completely
8-9	0 (0)	2 (22.2)	2 (12.5)	know
3-7	3 (42.8)	3 (33.4)	6 (37.5)	know partially
0-2	2 (28.6)	4 (44.4)	6 (37.5)	do not know

Table 13. *Subtraction Task- number and percentage of children in the both years of the research (combined method)*

Correct answers	Number of children in June (%)	Number of children in December (%)	Total (%)	Level
10	2 (28.6)	1 (11.1)	3 (18.7)	know completely
8-9	1 (14.3)	2 (22.2)	3 (18.7)	know
3-7	4 (57.1)	5 (55.6)	9 (56.3)	know partially
0-2	0 (0)	1 (11.1)	1 (6.3)	do not know

The 25-th percentile, median and 75-percentile for all three tasks in both years of the research are shown in Tables 14, 15 and 16. One can observed that children who learned numbers and arithmetic operations using the combined method reach the best results in terms of 25-th percentile, median and 75-percentile.

Table 14. *Traditional method*

Task	25-th percentile	Median	75-th percentile
Numbers	10	11	11
Addition	4.5	7.5	9
Subtraction	3	4.5	6

Table 15. *Scratch method*

Task	25-th percentile	Median	75-th percentile
Numbers	9	10	11
Addition	4	5.5	9.75
Subtraction	1.25	3	8.5

Table 16. *Combined method*

Task	25-th percentile	Median	75-th percentile
Numbers	10.25	11	11
Addition	8.25	9.5	10
Subtraction	5.25	7	8.75

Figure 3 shows a comparative view of the results for all three groups in the first year of research. Based on all the obtained results, it can be concluded that the children from the third group who learned using the combined method outperform acievements in the other two groups of children. The obtained results show that all children in the third group know or completely know numbers, digits and the operation of addition, and 42.9% of them know the operation of subtraction, because each one gave a maximum of two incorrect answers. The obtained results reveal that the children have overcome the subtraction operation the worst in all three groups, but even in this case, the children who learned using the combined method again outperform achievements of children in the other two groups, that is, slightly less than half of the children (42.9%) know the subtraction operation.

Figure 4 shows a comparative view of the results for all three groups in the second year of the research. Based on all the obtained results, it can be concluded that the children from the third group who learned using the combined method reached the best achievements. The obtained results show that 88.9% of children from the third group know or completely know numbers and digits, two-thirds of children (66.6%) know or completely know the operation of addition and a third of children (33.3%) the operation of subtraction because they all gave maximum of two incorrect answers. The obtained results show that the children from all three groups have overcome the subtraction operation the worst, but that even in this case, the children who learned using the combined method again outperform achievements of children in other two groups, that is, a third of the children (33.3%) know the subtraction operation.

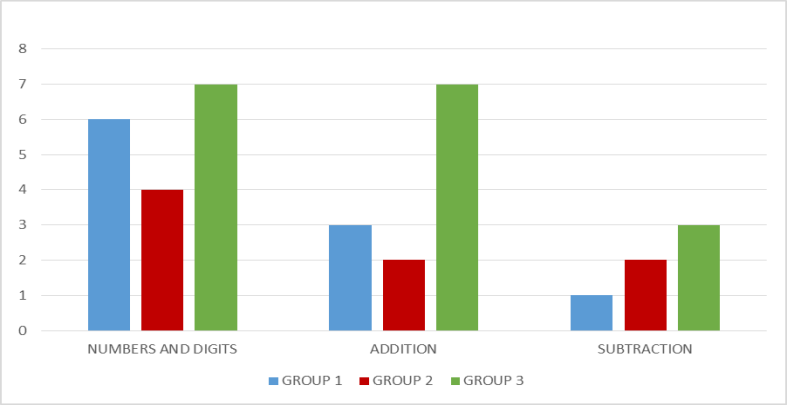

Figure 3. Results in the first year of research

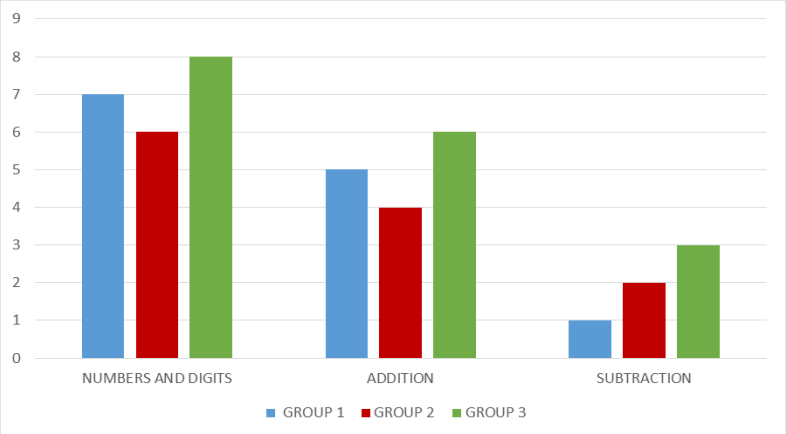

Figure 4. Results in the second year of research

Table 17. *Kruskal-Wallis test for test results*

Task	N	H	p
Addition	48	8.067	0.018
Subtraction	48	7.296	0.026

In the Table 17 obtained values of Kruskal-Wallis test for test results are given. The obtained H values reveal that at significance level $p < .05$ there is statistically significant difference in the effect of these three methods on the mastering of the arithmetic operations in children of preschool age.

Table 18 shows Skewness and Kurtosis values for all three groups and both arithmetic operations.

Table 18. *Skewness and Kurtosis for all three groups*

	I		II		III	
	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
Addition	1.078	3.437	-0.146	1.870	-1.564	5.067
Subtraction	-0.265	2.381	0.449	1.735	-0.311	2.624

Having in mind sample size (N<20) and results of Skewness and Kurtosis test, it was decided to use a non-parametric test. The comparison of different learning methods in order to determine the achievement differences was done on the basis of the Mann-Whitney U test results. The measure for children's achievement in mastering arithmetic operations was the number of correct answers. The software package SPSS was used to perform the Mann-Whitney U test and calculate the p-value. Below is the null hypothesis in the Mann-Whitney U test for different tasks and groups being compared:

1. There is no statistically significant difference in the distribution of the number of correct answers when comparing the traditional (I) and Scratch (II) method of learning addition.
2. There is no statistically significant difference in the distribution of the number of correct answers when comparing the traditional (I) and Scratch (II) method of learning subtraction.
3. There is no statistically significant difference in the distribution of the number of correct answers when comparing the traditional (I) and combined (III) method of learning addition.
4. There is no statistically significant difference in the distribution of the number of correct answers when comparing the traditional (I) and combined (III) method of learning subtraction.

The comparative view of the Mann-Whitney U test results for the traditional (I) and Scratch (II) method of learning arithmetic operations is given in Table 19. The obtained U values imply that at significance level $p < .05$ there is no statistically significant difference in the effect of these two methods on the mastering of the arithmetic operations. Hence, the null hypothesis is accepted for both arithmetic operations. Also, the findings reveal the possibility of using the visual programming language Scratch in preschool education for learning arithmetic operations having in mind that children who learned in this way showed similar results as children who learned using a well-established traditional learning method.

For both arithmetic operations, the practical significance of the research results was examined, and in that purpose the effect size - Cohen's coefficient was determined. In the Table 19, it can be noticed that d=0.2 for addition and d<0.2 for subtraction which means that effect size is small for both arithmetic operations.

Table 20 gives the comparative view of the Mann-Whitney U test results for the traditional (I) and combined (III) method of learning arithmetic operations. The values of the obtained U tests (U=65.50, p= .016) are statistically significant at level $p< .05$ and imply that the combined (III) learning method has statistically better effects on the adoption of the arithmetic operation addition. Furthermore, combined (III) method has statistically better impact in mastering the arithmetic operation subtraction (U=59, p=.008), even at a significance level of $p< .01$. Thus, the null hypothesis is refused and the alternative hypothesis is accepted for both arithmetic operations. The findings reveal that the blend of well-established traditional learning method and the potential of the visual programming language Scratch for developing algorithmic thinking enables reaching the best achievments regarding outcomes of learning arithmetic operations in preschool age.

Table 19. *Comparison of the traditional (I) and the Scratch (II) method of learning arithmetic operations addition and subtraction*

	I		II		M-W U test		
	MR	N	MR	N	U	p	d
Addition	17.41	16	15.59	16	113.50	.590	0.20
Subtraction	16.94	16	16.09	16	121.50	.809	0.02

N-Number of children; MR-Mean Rank

Table 20. *Comparison of the traditional (I) and the combined (III) method of learning arithmetic operations addition and subtraction*

	I		III		M-W U test		
	MR	N	MR	N	U	p	d
Addition	12.59	16	20.41	16	65.50	.016	0.91
Subtraction	12.19	16	20.81	16	59.00	.008	1.05

N-Number of children; MR-Mean Rank

For both arithmetic operations, the practical significance of the research results was examined, and the effect size - Cohen's coefficient was determined. In the Table 20, it can be noticed that d>0.8 and effect size is large for both arithmetic operations, which shows that there is a practical significance of the determined better effect of combined (III) method in comparison with the traditional (I) method in mastering the arithmetic operations of addition and subtraction.

The research findings show that the combined method is the most effective for learning arithmetic operations of addition and subtraction in preschool education. On the other hand, it has been shown repeatedly that learning arithmetic operations only using the visual programming language Scratch is less effective than the traditional or combined learning method. The reason for these findings could be the fact that Scratch is primarily intended for younger school age children and is not suitable for independent use in preschool age, but in combination with a well-established traditional learning method, it reveals its potential and enables the best achievements, thereby contributing to the improvement of learning arithmetic operations in preschool education. It should be noted that there are researches that also indicate the benefits of using the visual programming language Scratch for learning mathematics in general (Fauziah, Rahayu and Putri, 2024; Imawati and Shubchan, 2018; Sarifah, Nugroho, Marini, Yarmi, Safitri and Dewiyani, 2023), but the aforementioned researches relate to improving learning outcomes for lower elementary school students. Fauziah et al. (2024) studied the impact of implementing the Scratch-assisted problem based learning model on mathematical comprehension ability and also came to the conclusion that Scratch contributes to improving ability compared to the traditional learning model. Research findings (Imawati and Shubchan, 2018) showed that using of Scratch proved to be effective in helping students to understand mathematics. Sarifah et al. (2023) recommends using Scratch-based interactive games in order to increase interest in learning matematics in second grade of elementary school. On the other hand, there are researches related to examining the potential of programming for learning mathematics in general in preschool education. Somuncu and Aslan (2022) determined that the programming has a significant effect on mathematical reasoning skills of chlidren. In the research regarding the impact of project-based learning and visual programing language Scratch on the achievements of preschool children in mastering of arithmetic operations, authors (Sovilj-Nikić and Marinković, 2024) indicate that visual programming language Scratch is an exceptional supplement to the project-based learning of arithmetic operations. Palmer (2017) also indicates to the extraordinary potential of using programming to teaching mathematics in preschool education.

The results of this research reveal that subtraction is more complicated arithmetic operation than addition for children in all three groups. However, it could be noticed that no child knows the subtraction operation completely in the first group, while in the other two groups there are children who know subtraction completely. These findings may indicate the potential of the visual programming language Scratch in supporting the learning of subtraction.

The effect size shows that obtained results have also practical significance and could stimulate cur-

riculum developers to implement the visual programming language Scratch in preparatory preschool programs for learning arithmetic operations in addition to the already established traditional learning method. Also, these findings may encourage investments in ICT equipment of preschools as well as further informal education of preschool teachers regarding application of visual programming languages and ICT in general.

Conclusions

Listening to the children and following their interests and needs to learn something completely different in the educational work in the preschool institution, the idea arose to use the visual programming language Scratch for learning numbers, digits and arithmetic operations of addition and subtraction. The obtained values of U tests are statistically significant and reveal that the children from the experimental group, in which the combined learning method was applied, outperform achievements of children in the other two groups in both years of the research. Also, it could be observed that the subtraction operation is the worst mastered in both years of the research in all three groups. But, even in this case, the children who learned using the combined method again reached the best achievements, i.e. more than a third of the children knew the subtraction operation after learning.

The results of this research lead to the conclusion that the harnessing of the visual programming language Scratch in preschool education is an excellent complement to the traditional learning method. Also, during the research, it was observed that children think logically through algorithms by using the visual programming language Scratch which enables them to acquire new knowledge and understand mathematical and logical concepts through play. It should also be noted that there are certain limitations to the research conducted. Based on the test results, it was determined that children who learned using the combined learning method have better achievements than the other two groups at the time of testing, immediately after the implementation of the teaching content. Therefore, in further research, it would be desirable to examine whether this method is also more effective in terms of the durability of knowledge.

Finally, it should be emphasized that the visual programming language Scratch is primarily intended for younger school age and that the findings of this research reveal the potential of harnessing the visual programming language Scratch to improve the learning of arithmetic operations in preschool age, which certainly represents a new and unique contribution of this research and a good basis for further research. In future, it would be useful to examine the effectiveness of using this method for learning content from other areas in order to determine whether the visual programming language Scratch is also an exceptional complement to the traditional method of learning other teaching topics in preschool education, which would enable the generalization of the results obtained.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization, S.S.N. and J.Ć.; formal analysis S.S.N.; investigation J.Ć.; methodology, S.S.N. and J.Ć.; visualization S.S.N.; writing—original draft preparation, S.S.N.; writing—review and editing, S.S.N.. All authors have read and agreed to the published version of the manuscript.

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